Claims

[c1] A method of controlling fuel injection timing in a compression ignition engine including an engine block having at least one cylinder, said method comprising:
monitoring a position of a piston reciprocating in each cylinder between a top dead center (TDC) position and a bottom dead center (BDC) position; and
injecting a pre-determined quantity of fuel into each cylinder when the piston is at least one of reciprocating from said TDC toward BDC during an intake stroke, and at BDC reciprocating toward TDC during a compression stroke.

[c2] A method in accordance with Claim 1 wherein injecting a pre-determined quantity of fuel comprises injecting liquid diesel fuel.

[c3] A method in accordance with Claim 1 further comprising:
regulating a temperature of the fuel supplied to the at least one injector; and
regulating a pressure of the fuel supplied to the at least one injector.

[c4] A method in accordance with Claim 1 further comprising:
regulating a temperature of a supply of combustion air; and
regulating a pressure of a supply of combustion air.

[c5] A method in accordance with Claim 1 wherein controlling fuel injection timing further comprises controlling fuel injection timing of a railroad diesel locomotive engine.

[c6] A method in accordance with Claim 1 wherein at least one fuel injector is mounted in at least one cylinder head covering each cylinder, said method further comprising:
injecting a first pre-determined quantity of fuel into each cylinder at a crank angle of between about negative three hundred sixty degrees and about zero degrees; and
injecting a second pre-determined quantity of fuel into each cylinder at a crank angle of between about negative forty five degrees and about twenty degrees.

[c7] A method in accordance with Claim 1 wherein said engine includes at least one fuel injector mounted in a combustion air inlet plenum, in flow communication with each cylinder, the fuel injector includes a nozzle, the nozzle at least

partially within the combustion air inlet plenum, said method further comprising injecting a pre-determined quantity of fuel into each cylinder at a crank angle of between about negative three hundred sixty degrees and about three hundred sixty degrees.

[c8] A method in accordance with Claim 1 wherein injecting a pre-determined quantity of fuel further comprises injecting a quantity of fuel into each cylinder such that the fuel/air equivalence ratio of the fuel/air ratio in each cylinder at ignition is between, approximately 0.10 and 1.00.

[c9] A method in accordance with Claim 8 wherein injecting a quantity of fuel into each cylinder further comprises injecting a quantity of fuel into each cylinder such that the fuel/air equivalence ratio of the fuel/air ratio in each cylinder at ignition is between, approximately 0.20 and 0.60.

[c10] A method in accordance with Claim 8 wherein injecting a quantity of fuel into each cylinder further comprises injecting a quantity of fuel into each cylinder such that the fuel/air equivalence ratio of the fuel/air ratio in each cylinder at ignition is between, approximately 0.75 and 0.85.

[c11] A method in accordance with Claim 1 wherein injecting a pre-determined quantity of fuel comprises injecting a pre-determined quantity of fuel into each cylinder using a common rail fuel injection system.

[c12] A method in accordance with Claim 1 wherein injecting a pre-determined quantity of fuel comprises injecting a pre-determined quantity of fuel into each cylinder using an unit pump and unit injectors fuel injection system.

[c13] A compression ignition engine comprising:
an engine block comprising at least one cylinder;
at least one cylinder head covering said at least one cylinder;
a piston reciprocating in said at least one cylinder between a top dead center (TDC) position and a bottom dead center (BDC) position;
a combustion air inlet plenum in flow communication with said at least one cylinder; and
a fuel injection system comprising at least one fuel injector, said system

configured to inject fuel into said at least one cylinder when said piston is at least one of reciprocating from said TDC toward BDC during an intake stroke and at BDC reciprocating toward TDC during a compression stroke.

[c14] An engine in accordance with Claim 13 wherein said fuel is liquid diesel fuel.

[c15] An engine in accordance with Claim 13 wherein said engine comprises a railroad diesel locomotive engine.

[c16] An engine in accordance with Claim 13 wherein said engine comprises sixteen cylinders.

[c17] An engine in accordance with Claim 13 wherein said engine comprises twelve cylinders.

[c18] An engine in accordance with Claim 13 wherein said fuel injection system is configured to supply a regulated quantity of temperature regulated, pressure regulated fuel to at least one fuel injector.

[c19] An engine in accordance with Claim 13 that further comprises at least one fuel injector mounted in said at least one cylinder head, said at least one fuel injector comprises a nozzle, said nozzle at least partially within its respective cylinder, said fuel injection system configured to inject a first quantity of fuel into each cylinder at a first pre-determined position of it"s respective piston in said engine cycle and inject a second quantity of fuel into said cylinder at a second pre-determined piston position in said engine cycle, said second pre-determined position of it"s respective piston occurring later in said cycle than said first pre-determined piston position.

[c20] An engine in accordance with Claim 19 wherein the first pre-determined piston position in said engine cycle corresponds to a crank angle of between about negative three hundred sixty degrees and about zero degrees.

[c21] An engine in accordance with Claim 19 wherein the second pre-determined piston position in said engine cycle corresponds to a crank angle of between about negative forty five degrees and about twenty degrees.

[c22] An engine in accordance with Claim 13 wherein said fuel injection system is configured to inject a quantity of fuel into each said cylinder such that the fuel/air equivalence ratio of the fuel/air mixture in said cylinder at ignition is between about 0.10 and about 1.00.

[c23] An engine in accordance with Claim 22 wherein said fuel injection system is configured to inject a quantity of fuel into each said cylinder such that the fuel/air equivalence ratio of the fuel/air mixture in said cylinder at ignition is between about 0.20 and 0.60.

[c24] An engine in accordance with Claim 22 wherein said fuel injection system is configured to inject a quantity of fuel into each said cylinder such that the fuel/air equivalence ratio of the fuel/air mixture in said cylinder at ignition is between about 0.75 and 0.85.

[c25] An engine in accordance with Claim 13 that further comprises at least one fuel injector mounted in said combustion air inlet plenum, said at least one fuel injector comprises a nozzle, said nozzle at least partially within said combustion air inlet plenum, said fuel injection system configured to inject a pre-determined quantity of fuel into each cylinder at a pre-determined piston position in said engine cycle.

[c26] An engine in accordance with Claim 25 wherein said pre-determined piston position in said engine cycle corresponds to a crank angle of between about negative three hundred sixty degrees and about three hundred sixty degrees.

[c27] A railroad locomotive comprising:
a compression ignition engine comprising an engine block comprising at least ten cylinders;
at least one cylinder head covering said cylinders;
a piston reciprocating in each said cylinder between a top dead center (TDC) position and a bottom dead center (BDC) position;
a combustion air inlet plenum in flow communication with said cylinder; and
a fuel injection system comprising at least one fuel injector, said system configured to inject fuel into said cylinders at a crank angle of between about

negative three hundred sixty degrees and about three hundred sixty degrees.

[c28] A locomotive in accordance with Claim 27 wherein said fuel injection system comprises at least one fuel injector mounted in said cylinder head, said fuel injector comprises a nozzle that is at least partially within said cylinder, said system is configured to inject said fuel at a first pre-determined piston position in said engine cycle and inject a second quantity of fuel into said cylinder at a second pre-determined piston position in said engine cycle, said second pre-determined piston position occurring later in said cycle than said first pre-determined piston position.

[c29] A locomotive in accordance with Claim 28 wherein the first pre-determined piston position in said engine cycle corresponds to a crank angle of between about negative three hundred sixty degrees and about zero degrees.

[c30] A locomotive in accordance with Claim 28 wherein the second pre-determined piston position in said engine cycle corresponds to a crank angle of between about negative forty five degrees and about twenty degrees.

[c31] A locomotive in accordance with Claim 27 wherein said fuel injection system is configured to inject a quantity of fuel into said cylinder such that the fuel/air equivalence ratio of the fuel/air mixture in said cylinder at ignition is between 0.10 and 0.85.

[c32] A locomotive in accordance with Claim 27 that further comprises at least one fuel injector mounted in said combustion air inlet plenum, said fuel injector comprises a nozzle, said nozzle at least partially within said combustion air inlet plenum, said fuel injection system configured to inject a pre-determined quantity of fuel into said cylinder at a pre-determined piston position in said engine cycle.

[c33] A locomotive in accordance with Claim 32 wherein said pre-determined piston position in said engine cycle corresponds to a crank angle of between about negative three hundred sixty degrees and about three hundred sixty degrees.

[c34] A railroad locomotive comprising:

a compression ignition engine comprising an engine block comprising at least ten cylinders;
at least one cylinder head covering said cylinders;
a piston reciprocating in each said cylinder between a top dead center (TDC) position and a bottom dead center (BDC) position;
a combustion air inlet plenum in flow communication with said cylinder; and
a fuel injection system that comprises at least one fuel injector mounted in said at least one cylinder head, said fuel injector comprises a nozzle that is at least partially within said cylinder, said system configured to inject said fuel at a first pre-determined piston position that corresponds to a crank angle of between about negative three hundred sixty degrees and about zero degrees., and inject a second quantity of fuel into said cylinder at a second pre-determined piston position that corresponds to a crank angle of between about negative forty five degrees and about twenty degrees, such that a fuel/air equivalence ratio of the fuel/air mixture in each said cylinder at ignition is between 0.10 and .85.

[c35] A railroad locomotive comprising:
a compression ignition engine comprising an engine block comprising at least ten cylinders;
at least one cylinder head covering said cylinders;
a piston reciprocating in each said cylinder between a top dead center (TDC) position and a bottom dead center (BDC) position;
a combustion air inlet plenum in flow communication with each said cylinder; and
a fuel injection system comprising at least one fuel injector mounted in said combustion air inlet plenum, said fuel injector comprising a nozzle, said nozzle at least partially within said combustion air inlet plenum, said system configured to inject fuel into said cylinders at a crank angle of between about negative three hundred sixty degrees and about three hundred sixty degrees, such that a fuel/air equivalence ratio of a fuel/air mixture in said cylinder at ignition is between 0.10 and .85.